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Educating Students for the Collaborative Workplace: Facilitating Interdisciplinary Learning on Accredited Construction Courses

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This paper addresses the provision of interdisciplinary learning opportunities for students enrolled on accredited Built Environment, Design and Construction courses in Higher Education Institutions (HEIs) in the UK. The paper cites published literature from across disciplinary boundaries, demonstrating a need for, and an interest in, interprofessional collaborative learning. Case studies of seven projects from four UK HEIs are reviewed and strategies compared. The studies demonstrate the value of such teaching; the context within which the teaching is provided; some examples of good practice; of disincentives and of barriers; and student feedback. Key shared characteristics begin to suggest a taxonomy of collaborative projects. The paper concludes with suggested actions and/or strategies that could be employed by Schools, HEIs and/or Institutions to further incentivise such teaching.

The genesis for this paper was the proceedings of a highly valuable cross-institutional seminar, held at Heriot-Watt University in August 2015, generously funded by the CHOB Small Grants Scheme.

Key Words: Collaborative learning; interprofessional learning; multidisciplinary; built environment; design

Introduction

Educational programmes in the UK at undergraduate level may be accredited as 'routes to chartered status' for architects, engineers, contractors and surveyors. These programmes are curated to meet criteria from those professional institutions, all of which require courses to deliver skills in (for example) teamworking, collaborative decision-making, communication, and knowledge of co-professionals. Explicit mentions of *collaboration* (criteria A2, C1, D3, Engineering Council, 2014), *users and co-professionals* (criteria GC 5.1, 6.1, 7.3, 11.2, RIBA, 2011), *respect for team members* (criteria 2.2, 2.3, 2.6, CIOB, 2013), and *Managing People... Communication and Negotiation* (APS Competencies, RICS, 2014), seek to ensure that putative professionals emerge from education ready to perform at a high level, as part of multidisciplinary teams in complex scenarios.

Many HEIs meet these required criteria through small- and larger-group tasks and projects within the students' disciplinary cohort. Some expand this to include longitudinal collaboration across yeargroups. The premise of this paper, illustrated by *Figure 1*, is that wider cross-disciplinary collaborative working is an essential part of professional education in developing skills for industry practice. It is not sufficient to teach 'teamworking' in intra-disciplinary groups. Effective learning can only take place in larger, multidisciplinary team scenarios.

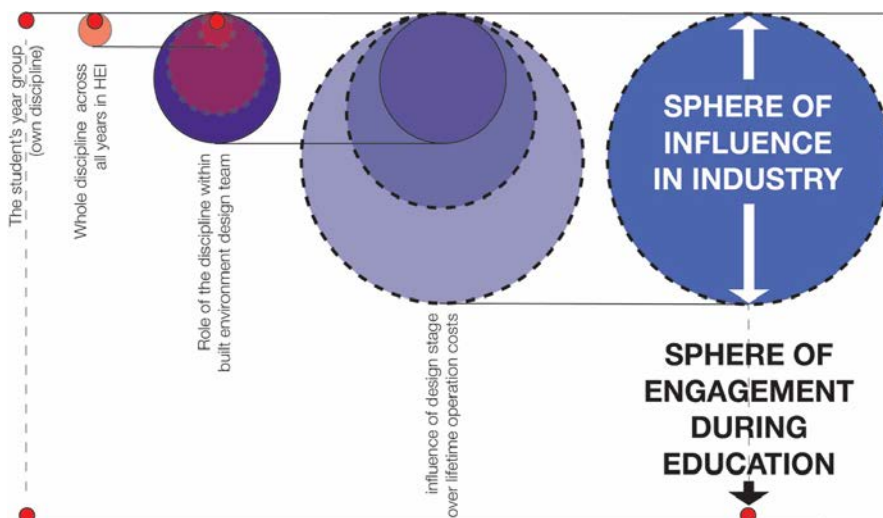


Figure 1: Sphere of experience in Education vs sphere of influence in industry practice.
[Graphic demonstrated proportional relationships of statistical team member input]
(MacLaren and Birchall, 2016)

The current student, emerging into industry, must exercise ‘the ability to take the initiative and make appropriate decisions in complex and unpredictable circumstances’, a requirement of architectural (design) education (RIBA, 2011). While there is ongoing debate about the value of, or devalue in higher education, ‘The design industry still values degree-level study: research last year by Creative & Cultural Skills found that 76% of employers expect to employ only graduates in design roles...but that 58% of those employers also said that they are dissatisfied with what those graduates bring to the workplace, citing communication, commercial awareness and basic business skills as lacking’ (Design Council, 2016). We will argue that these skills can be effectively developed and delivered through *collaborative multidisciplinary design projects*. Cultivating good communication through exposure to interdisciplinary collaboration demonstrates to students the critical role that relationship building plays in establishing, and sustaining a practice.

Industry Context

Emerging in the nineteenth century, qualities of ‘professionalism’ have been the subject of much educational theory (Schön 1983, Eraut 1994, Guile, 2010, Young & Muller 2014). A relatively simple definition might be “*trust and the exercise of judgment based on specialist knowledge.*” (Duffy & Rabeneck, 2013). Professional Institutions seek to engender educational programmes that teach these qualities, and base their accreditation criteria on extant professional roles and activities.

This presumption of stasis in future professional transactions is not logical in a rapidly expanding sharing economy. The increasingly collaborative, complex construction industry in contemporary society requires instead, the engagement of agile, networked, cross-disciplinary professionals. (Susskind & Susskind, 2015). Navigating this context requires individuals to have a good holistic knowledge of their industry, a tacit understanding of the

Commented [MA1]: Need to check exact quote!

roles of others, an ability to apply theoretical knowledge to complex scenarios, and a sense of their place within the wider team. Increasing use of technology requires heightened communications skills, and countless examples from contemporary construction industry reports, regulations and commentaries demonstrate the growing requirement for interdisciplinary collaboration across the built environment (Gov't Construction Strategy 2011, BAF BIM/education report 2013, 'Collaboration for Change', Morrell 2015).

Commented [MA2]: I think this also a Susskind quote- find!

Higher Education Context

HEI funding incentives and Industry aspirations for future professional practice are not aligned. In pursuit of funding and league-table recognition, HEIs seek to appoint PhD-qualified, specialist candidates, with specialist research profiles, to permanent academic posts. Meanwhile, government and Industry policy pushes in the direction of collaborative practice, supported to some extent by institutional accreditation criteria requiring generalist abilities and holistic industry awareness.

This demonstrates a disparity between the emerging 'career academic' (Tennant et al, 2015), tending by nature to be specialist and discipline-specific, and the increasing demands for inter- and cross- professional training from the workplace. The trend toward specialist HEI educators leads to built environment programmes being led by narrow specialists, themselves without broad industry experience. Academic course leaders in this scenario may not realise the potential benefits of cross-disciplinary collaborative education: and in any case, may not possess the wider skillset or connections to enable the introduction of such programmes.

There is a growing dichotomy between the aims of accredited professional education and the nature of the UK Higher Education environment.

Case Studies

At a seminar in Summer 2015, academics from seven institutions met to share their experience of collaborative cross-disciplinary projects on built environment courses. The subsequent examples are surmised below, and compared in Table 1, Figure 2.

Case Study 1:

Leeds Beckett University; Final Year Undergraduate Students

Background

The School of the Built Environment and Engineering delivers a collaborative learning project to its final year undergraduate students which covers the disciplines of: Quantity Surveying, Building Surveying, Architectural Technology and Project Management. It is designed to enable both full time and sandwich students to work together to use their particular disciplines to produce an overall development project with feasibility study and rationale.

The learning outcomes are both discipline-based for each specific area, and generally team-based in relation to how groups and teams form and work together. The team working learning experience is also enhanced by a reflective essay summarising how the team developed throughout the 12 week period of its existence.

Commented [MA3]: Mark, I think this is a brilliant summary of a lot of complex things. It leaves me with a couple of questions on assessment tho: how are the various bits (technicaldiscipline / teamworking/ reflective essay) split percentage-wise in assessment?

[illegible]

Figure 2: Table comparing Case Study Projects from workshop participants

Project Format

The project is a 'development pitch' based on a site where the students are placed in teams and are asked to provide conceptual designs and costings as a pitch to developers. They must also provide reports particular to each discipline which align with the overall development proposal.

Initially the project was based on an imaginary site to the west of Leeds but feedback from the students highlighted that they were looking for more information on the site relating to logistics and the surrounding area that could not be provided for the imaginary site. This feedback was considered and a local large development site, the old Tetley Brewery, was researched and used for the following year's cohort.

Observations were made during the delivery of the module by the lecturers, with particular attention to team working and dynamics. It was noted that the teams struggled to 'gel' early on as they were not able to choose their members. This was a conscious decision to force the teams to work with other students than they would normally do, so a strategy for enhancing team work was reviewed. The strategy was to use Belbin's *self-perception inventory* (Belbin, 1993) to get team members to understand their roles and traits to improve their ability to work together.

A further development in the team working has been to require the teams, after completion and review of the self-perception inventory, to go away and choose a team building exercise of their own and then deliver a presentation on it the following week.

Summary

At each junction of change the students' feedback has been reviewed along with their engagement with the project to ensure they are receiving an engaging and satisfying learning experience. Feedback has seen a positive increase after each change has been applied. Observations of the students and how they perform in their groups has also shown they form a stronger relationship much quicker than previously.

The change from an imaginary site to a real one with information freely available has produced proposal that are more in line with Local Authority Planning requirements as well as better informed. The students have even provided material from other sources for use in following years to enhance future students' understanding of the site. The ability to visit the site has enable students to identify areas that would otherwise not have been considered which has further enhanced the learning of the students.

Case Study 2:

Heriot Watt University; Final Year Undergraduate Students

Background

For over 10 years, Heriot-Watt University has included, in the final year of its undergraduate programmes in Civil/Structural/Architectural Engineering, Construction Project Management, Real Estate, Quantity Surveying and Urban Planning and Property Development, an immersive 'collaborative week' exercise. The aim of this is to expose students across built environment disciplines within the University to multi-disciplinary project working in a real-life context.

Project Format

In week 1 of semester 1 of final year, built environment students are allocated into multi-disciplinary groups of around 1-15 students. These groups work for 4 days to prepare a development proposal for a real site which they present to staff and students on day 5. While the proposal/presentation is not formally assessed, for the remainder of the semester the students use their experience on the week to inform an assessed 'Design Project' course.

Summary

Students are fully engaged with the exercise for the week since all other classes are cancelled, and they find the experience challenging but informative, and this feeds into later 'reflective writing' exercises for instance. They develop skills in group dynamics as well as group presentation, and also broader understanding of related disciplines. This exercise is regularly rated as the most memorable of their student experience.

Case Study 3:

Edinburgh College of Art, University of Edinburgh; First Year Undergraduate Students

Background

In the academic year 2012/2013, The University of Edinburgh, Edinburgh College of Art included in their first year curriculum a collaborative project for first year students known as Risk. The aim of this was to expose design students to working with colleagues in different disciplines on a project with a focus to define what they felt were risks in their lives and contemporary life, and exploring ways of expressing and addressing those issues. All staff in the Design School were asked to pitch ideas for these projects, with a budget of £1000 available to run the successful pitch.

Project Format

The successful pitch was called Breaking Barriers. Its format looked at the concept of barriers and exclusion, with a focus on walls such as the Flodden Wall, which surrounded the neighbouring Edinburgh Castle in the 16th century, and Mark Wallinger's State Britain project. The lead Lecturer also involved a professional environmental artist. This external source was important as it gave the students first-hand experience into the practice of an industry professional, whilst working within that discipline themselves. During the initial intensive week students started working in mixed groups of 3 – 4 students; towards the end of the week they were able to work individually.

Students undertook a series of research and design development tasks that resulted in a combined visual output. It got them to express their own experiences of risk and barrier through building three dimensional scenes in a set of uniformed cardboard boxes (120 in total). This gave them all a common output in terms of its size, but they were free to explore the inhabitation of their individual box. On the final day they worked together to build these vitrines into a barrier across the central exhibition space of Edinburgh College of Art, known as the sculpture court. This was then destroyed by the students as the climax of the final exhibition event. For the remainder of the semester each student produced, within their own department, a portfolio, blog or physical item that was inspired by the work they undertook in the initial week.

Summary

In conclusion, when working across different student disciplines, this project found a positive structural basis in a mix of the unfamiliar (in the case of this project 'How do you define risk?'), along with the familiar (a project structure that involves the sequential stages of

research, design development and presentation of final ideas). Also by combining mixed-disciplinary groups and individual work, the students were able to express their own ideas, but also learn from the different approaches other disciplines took to the tasks set. For example the illustration students tended to draw everything in great detail before approaching the making of a vitrine, whereas the product design students moved quickly onto the construction.

The challenge was to keep them motivated throughout, and a key lesson learned from this was to structure the course so that every day there were clearly defined goals and a transparent progression of work towards a final outcome. This allowed the project to gain momentum as it progressed. Three years on, tutors have witnessed the growth of some of these professional relationships throughout the courses, with that academic cohort, who are now in their final year, being much more proactive and confident in asking for advice from other disciplines in relation to their projects, than other students.

Case Study 4:

Heriot Watt University; Third Year Undergraduate Students

Background

The Illusion of Memory is a Quality Assurance Agency (QAA) & Heriot Watt University (HWU) funded project under the QAA Enhancement Theme of "Student Transitions". The project was designed to enhance student transitions for Level 10 SCQF direct entry (DE) students entering into the 3rd year of study at HWU within the disciplines of Interior design and Woven Textile Design; but was also intended to suggest potential interdisciplinary research possibilities to staff in both schools. The collaborative project shared a common theme of ageing in place, designing older age friendly environments, especially designing for individuals living with dementia.

Project Format

The Illusion of Memory has had 2 phases thus far, each engaging diverse input from outwith HWU: contributions from manufacturers, designers, clients and policymakers. The first phase culminated in an MSP sponsored event consisting of an exhibition and presentation of student work at Scottish Parliament in May 2015, improving HEI engagement and raising the awareness of a wider global health and built environment themes. The second phase made more provision for students and staff to collaborate and co-design between disciplines alongside the dementia user groups, and internal PhD candidates. More effort was made to provide opportunities for the student groups to collaborate and share ideas and experiences within the first semester. This took the form of small group discussions encouraging interdisciplinary project teams to form naturally, thus improving the final outcome of their collaborative work throughout semester two, but also assisting with DE student transitions during the vital transitional period of semester 1.

Summary

The achievements of this collaborative project have had a powerful impact, influencing lecturers and students alike resulting in richer ideas, wider knowledge of interdisciplinary working and understanding of discipline specifics, increased working with external industry partnerships, the integration of research upon the curriculum, the development of transferable skills and the enhancement of transitional processes from FE throughout HE and into the workplace.

Collaborative projects require individuals to be gutsy, committed and devoted to applying a different way of working. There are inevitable obstacles requiring resolve to successfully navigate. Collaborative working is about partnership, it requires individuals to look outward, to be flexible and accommodating to others' needs and ways of working, to share similar goals and experiences.

On reflection, this has been a pioneering project for HWU, deriving from an informal chat at a course board meeting between colleagues who had never spoken, resulting in what is now becoming an established programme within the curriculum. This interdisciplinary approach to teaching and learning will ultimately challenge the way we shape the future curricula offering further opportunities for similar projects to evolve.

Case Study 5:

Heriot Watt University and FE Colleges; HNC/HND and All Undergraduate Students

Background

This project, as the previous example, sought to ease Student Transitions, in particular at two stages:

- From College to University. Particularly relevant for Interior Design and Textiles students who articulate from HND courses direct into the third year of a BA(Hons) Degree.
- From University to Employment, through increasing interdisciplinary knowledge, client interaction, confidence, and through showcasing student work to local employers.

The project founded "Designing Live" (DL), an ongoing pedagogic vehicle for collaborative design events. DL is a series of stand-alone one-day design events, located outside of the university campus and engaging with industry.

Project Format

We staged a series of one-day design 'Charette' events during Semester 2 of the 2014-15 academic year. These followed a simple pattern: The events were free to sign up for, catered and managed by HWU staff; participating students are divided into mixed groups on arrival; the main activity was an intensive day of active design-based teamwork all on one site, finishing with a celebration in the evening alongside invited guests.

An example: the first event, "Designing Live: Home" was attended by 18 students, 50% of whom were current Heriot-Watt students. The challenge was to design, in teams, a student bedroom for an individual. The creation of this 'client' was a short 'ice-breaking' exercise on arrival, conducted by the newly-matched teams: characteristics developed by playing a lighthearted game of 'consequences'. The evening 'industry event' was promoted via email and twitter, achieving great social media traction on the day, when photographs of the event 'tweeted' were picked up by major local media sources such as Creative Edinburgh. Representatives from 8 local industry employers attended the evening event, speaking directly with the students and 'judging' their work for a small prize.

Summary

The events sought to develop skillsets that assist at the above transitional stages; individual confidence and teamworking skills were developed through exercises themed in other key areas; concept development, live build, and Client Presentation. These directly address known weaknesses in articulating college students and bolster self-assurance in graduating

students. The themes were developed from conversation with teaching staff and external examiner feedback.

The requirement to work as cross-disciplinary teams at different stages also reinforces confidence, communication and collaboration skills, presentation abilities: all essential qualities for graduating HWU students and in line with university-wide Graduate Attributes.

Finally the events also act as showcases for Heriot-Watt University in terms of outreach (when working with community) and industry engagement (invited professionals to evening gallery events). These experiences are key to Student Transition into the workplace, but also act as a promotional tool for the university in the community.

Case Study 6:

London South Bank University with 'Teambuild'; Undergraduate and Postgraduate Students

Background

Teambuild is an innovative, competition-based training format offered to students and young graduates in the construction industry. The competition is run by a registered Charity, 'Teambuild Association', comprising a board of 6 volunteer Trustees and two part-time administrative and executive staff, supported by a rotating group of recent alumni. 'Teambuild: the Construction Challenge' has been offered to students of LSBU annually since 2014, open to all students in the built environment school, from first year to PhD level, enrolled in full- and part-time studies.

The format allows 'real-world' commercial experience to be gained in a controlled environment, including interaction with varied practising industry professionals in a manner that allows trial and error, informal conversations and regular structured feedback. The two-day format is quick, efficient, and offers enough value to the industry representatives that they donate their time, making the event extremely affordable and attractive to universities, colleges, and commercial companies.

Project Format

The Teambuild administration match student applicants into teams, mixing age, experience, but primarily disciplinary specialism. The maximum number of people in a team is six. Over two days, the teams are fed a series of five briefs to answer in short (2-hour) periods, after which they must present their results to a team of 'judges'. The briefs are scenario-based, around a real working site local to the host university, and which participants have been given the opportunity to visit as a pre-session task.

The event is a competition; teams are assessed on their teamwork, communication and presentation skills, but NOT their technical prowess (despite being based around highly technical tasks). Formal, verbal feedback is given by judges to each team after each presentation, allowing them to develop their skills ready for the next presentation. The frequency of brief issue and presentation slot requires teams increasingly to delegate and work on tasks simultaneously. The first group task ('name your team'), issued before the event, is intended to allow strangers to form relationships quickly, without disciplinary pressure. Over 48 hours the complexity of group management increases exponentially, and the intense nature of the experience leads to memorable, effective learning of collaborative

and communication skills. Students also report an increased sense of disciplinary identity, realising the particular value of their specialist knowledge to a professional team.

Summary

The Teambuild experience seeks to plug a well-documented gap in construction industry training: the chasm between academic HE or FE training and the experience on the job. To date this has been offered at three HEIs around the UK. Participants in Teambuild gain industry knowledge, valuable workplace skills, and self-confidence. They vastly increase their own self-confidence, and personal value and effectiveness to their (future) employers; and the skills developed are in line with HEI's 'Graduate Attributes', an increasingly popular measure of general professional qualities. This statement is backed by consistent evidence from participant feedback, comments from participants' tutors and line managers, and responses from alumni of the competition.

Case Study 7:

*Duncan of Jordanstone College of Art and Design, University of Dundee;
Second and Third year Undergraduate Students*

Background

Since 2009, undergraduate students at DJCAD have been regularly engaging in the types of collaborative exchanges familiar to built environmental practitioners but still a relatively rare event in higher education. Officially formed in 2003, the 'Group for International Design Education' (GIDE) has a far longer history and celebrated its 10th anniversary at the Ljubljana event in 2013.

GIDE is a dynamic international network, of eight nations including Scotland, China, Germany, Switzerland, Belgium, Italy, England and Slovenia. Cyclical events that occur February to February, provide students with unusual intercultural design experiences. Here new working practices are established and different creative competences are forged.

GIDE collaborates annually with up to 200 participants from 8 nations and 4 disciplines in an international event. The GIDE experience has deliberately transformed what for many institution still remains not much more than a 'study-trip', bringing students and academics into direct contact with local enterprise and regional practitioners. Instead GIDE combines this with a symposium, a collaborative workshop, an exhibition and closing event. Creative outcomes from this international workshop week collectively help define a subsequent shared project delivered formally in the curricula across all eight GIDE partner schools in the following academic semester.

Project Format

Individuals are allocated a place in one of twelve international teams ensuring an interdisciplinary mix that maximizes the new learning opportunities in terms of exposure to peers' different design methods, competences and energy. Students who would typically be operating as independent [and isolated] creative practitioners in their home institutions, are confronted with new team experiences that will seem familiar to those in industry. Students are required to exercise their interpersonal skills.

Teams are supported by at least two guest tutors who take on new roles as 'producers' [to use a Hollywood analogy] tasked with empowering teams, facilitating back of stage rather than

acting out a role as 'director'. Students are 'the actors' and both producer and actor are primarily concerned with meeting the needs of the 'audience/client'. Tutor/ Producers also help individuals negotiate meaningful roles within their teams, who gradually take on the attributes of a design agency.

Teams are required to design a response to problems set, and judged [and often sponsored] by the regional enterprises familiar to the GIDE school hosting the international workshop week at that particular time. Design outcomes tend to rely upon the types of improvised low-fidelity approaches and quick and dirty methods, common to emerging participatory practice in industry. This nevertheless leads to higher-fidelity creative outcomes that can lie outwith either disciplinary domain.

Summary

In addition to providing students with exciting opportunities to enhance their career potential and develop relationships with international design peers [who might indeed become future business partners], the GIDE experience provides a successful platform for regional businesses to pilot ideas, generate public relations opportunities and work directly with academics. Each year the consortium publishes a research output combining theoretical and didactic papers alongside a selection of students' work to be published. Increasingly participants of the intensive international week are also working closely with PhD, Masters and active research groups.



Figure 3: CHOB Seminar Attendees and resulting shared learning points

Commonalities in Approach – Collaborative Characteristics?

The diversity and energy of the small sample of case studies above demonstrate the huge variety of inter-disciplinary collaborative learning models currently offered within higher education. It is hoped that the reader will be inspired by the short narratives presented above, and realise the various potentials offered by these projects in industry engagement, research catalysis, tacit knowledge development and building individual agency and confidence.

Whilst not wishing to generalise too far, sharing these experiences led to understanding of particular elements, common to many of the projects. Figure 3 highlights some specific common characteristics apparent to the authors.

PROJECT NAME / CHARACTERISTIC	<i>Interprofessional Studies</i> Leeds Beckett	<i>Collaborative Project</i> Heriot-Watt University	<i>Breaking Barriers: Risk</i> University of Edinburgh, ECA	<i>The Illusion of Memory</i> Heriot-Watt University	<i>Designing Live</i> Heriot-Watt University	<i>Teambuild</i> London South Bank University	<i>GIDE</i> University of Dundee, DICAD
<i>Example No.</i>	1	2	3	4	5	6	7
Collaborative project as a precursor to individual disciplinary activities		X	X	X			X
External Industry Practitioners involved	X	X	X	X	X	X	X
Enabled by 'one-off' funding application			X	X	X	X	
Part of main curriculum; assessment contributes to degree	X	X	X	X			X
Includes time off-campus	X	X	X	X	X	X	X
Technical / disciplinary-specific knowledge exchange required	X	X		X		X	
Uses 'competition' to incentivise multidisciplinary groups/teams	X	X			X	X	
Students from more than one institution		X			X		X
Organiser / Provider external to HEI/ operating across several HEIs*	Whilst this applies to only one of the projects featured here, two other established and growing projects featured at the seminar- <i>MERIT</i> and <i>Constructionarium</i> - have this characteristic.					X	

Figure 4: Table comparing selected characteristics of Case Studies. Two characteristics are common to all projects studied.

It can be seen that:

- External Industry Practitioners are engaged, to an extent, in every collaborative learning project presented.
- Every Collaborative Project includes time spent off-campus; a discipline-neutral territory and an explicit 'application' of academic knowledge outwith the institution.
- Activities which are part of the curriculum are likely to use collaborative tasks as a precursor to assessed, individual disciplinary-specific tasks.
- Several projects were generated in response to a call for proposals to receive funding for developing or enriching the student experience.
- It is common to use a 'competition' format, perhaps as a means of establishing a common goal, engendering collaborative endeavour within teams.

Further observations, not highlighted above:

- Projects are likely to be designed and run by staff with significant experience in industry, either before or alongside their academic career
-

Enabling Collaborative Practice

Whilst there is limited literature studying interprofessional education in Construction, the field is a popular area for study amongst other sectors: particularly in Healthcare.

'InterProfessional Education' (IPE) has specific, established representative bodies engaged in research and best practice in both the UK (CAIPE) and NCIPE and IPEC in the US. This relative wealth of academic enquiry into collaborative learning provides a basis for analysing the trends and characteristics noted above, in relation to understanding how best to enable these learning experiences universally in professional built environment education.

The World Health Organisation asserts 'there are mechanisms that shape how collaborative practice is introduced and executed.... these have been divided into three themes: institutional support mechanisms...; working culture mechanisms...; and environmental mechanisms' (WHO, 2010). The conclusions of the authors can be distributed between these categories: we shall take each of these in turn.

Institutional Support Mechanisms

- Set aside funding for cross-disciplinary activities
- Recognise explicitly the value of collaborative skill development in assessment, eg 'soft skills', professionalism, etc. There are indications that increased emphasis on 'Graduate Attributes' may be developing this awareness.

Working Culture Mechanisms

- Assure mutual respect between disciplines and the development of a shared language between disciplines (essential in staff as well as students!)
- Actively seek out live projects and active professionals close to the institution. Trust these professionals to contribute in direct contact with students
- Staff working on collaborative projects must themselves be comfortable with setting open-ended, complex briefs, the solutions to which they individually may not

themselves understand. This uncertainty, essential to developing collaborative skills and professional judgement, can be difficult for academic specialists to accept.

- An understanding of the level of direction required to allow students to best perform and demonstrate their skills, and operate as a team, whilst gaining experience from operating in an environment of ambiguity.
- Recognition that the value of collaborative projects is best evidenced in the process rather than the output: which has implications for both task design and assessment.

Environmental Mechanisms

- Timetable management: Collaborative projects require synchronization and disruption over multiple programmes. This can be extraordinarily difficult.
- 'Neutral' Territory. The importance of introducing team members in an environment where each feel equally able to contribute
- Digital technologies enable intra-team collaboration in ways and to an extent unprecedented in traditional teamworking formats. HEIs must lead in introducing future professionals to these emerging environments to support industry skill development.

Conclusions

It is intended that this paper document a selection of best-practice initiatives in collaborative interdisciplinary education in built environment disciplines, alongside a commentary linking the practical examples with wider regulatory and academic literature. The paper has also identified practical and theoretical shifts that may be made to encourage more widespread use of such teaching and learning practices.

'..the challenge for aspiring professionals is to develop the capability to use disciplinary knowledge, in conjunction with professional experience, as a resource in a specific context to pick out the salient features of that situation or event, and to then infer what follows and how to act' (Guile, in Young and Muller, 2014)

Key to the success of this process is taking students [and academics] deliberately out of the institutionalized frameworks that bind them - frameworks that often, ironically, restrict innovation. To succeed in this interprofessional, intercultural collaboration requires improvisation, both in mind-set and in design technique, and requires a willingness to operate with uncertainty whilst embracing risk, and risking failure.

Design, and specifically co-design are key skills in a world of rapid change and unpredictable unknowns. Professional roles in the built environment sector are evolving, and new formats of processes and transactions developing at an unprecedented rate. Successfully navigating this environment requires graduates will essential interprofessional skills, effectively acquired through collaborative inter-disciplinary projects in higher education.

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Appendix A: Participants in the original Seminar (August 2015) included:

Name	Surname	School
Mark	Phillipson	Glasgow Caledonian University
Pauline	Thompson	Heriot-Watt University
Rachel	Simmonds	University of Edinburgh
Paul	Kerlaff	Edinburgh Napier University
Mark	Wilson	Leeds Beckett University
John	McCarthy	Heriot-Watt University
Alison	Hamilton-Pryde	Heriot-Watt University
Sharon	Giannasi	West College Scotland
Marisa	Giannasi	West College Scotland
Fred	Bosché	Heriot-Watt University
Andy	Milligan	University of Dundee